Superiority of "maze-dull" animals on visual tasks in an automated maze [1, 2]

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Two major studies and a number of pilot studies involving 100 descendants of the Berkeley S_1 and S_3 strains of rats were accomplished in a versatile automated maze. Positive- and negative-reinforcement paradigms were used in separate experiments, and the "dull" S_3s consistently showed superior performance on visual-discrimination and reversal-discrimination problems. It is concluded that traditional "bright" and "dull" labels are clearly faulty for these strains.

Recently Markowitz & Sorrells (1969) presented results showing that descendants of the Tryon "maze-bright" and "maze-dull" animals differed in performance on an automated-maze task. However, this marked difference was contradictory to "traditional results." On a simultaneous light-dark discrimination problem, the "dulls" were significantly superior in terms of all criteria employed. It was hypothesized that the S_3 ("dull") strain was superior when the task was primarily visual rather than spatial, and argued that all inclusive lables such as "maze-bright" were ill advised. The conclusions were tentative for two reasons: (1) there was an opportunity for only partial replication; (2) negative reinforcement had been used exclusively in the automated maze.

The present paper includes information pertinent to these reservations. First, we have run two replications using negative reinforcement and a visual task, and in each case have confirmed that the S_3 animals exhibit shorter running time, fewer errors to criterion, and quicker reversal learning. In addition, we have developed a new automated maze which allows negative and/or positive reinforcement in an otherwise identical situation. S_3 animals show superior performance on a visual reversal discrimination task in this maze regardless of type of reinforcement. The use of positive reinforcement yielded even more significant differences than had been found using shock: there were no overlaps in distributions for the two strains on any of the measures recorded.

PROCEDURE

An automated maze (Fig. 1), essentially consisting of two Y mazes joined at their stems, was used in all studies. The two compartments of either end could be independently lightened or darkened. Motor-driven doors for each of the compartments were automatically controlled, as were the shock and food delivery mechanisms for each section of the maze. In studies where shock was used, it was delivered through the grid floor of the apparatus. A silent electronic shock scrambler (Markowitz & Saslow, 1964) was used to commutate the shock. In food-reinforcement studies, a motor-driven portion of the compartment wall was raised to expose the pellet dish on trials where the animal was to be reinforced. This was accomplished after the animal had made a choice and been "locked in," so that there were no differential cues with respect to food before the animal had completed a trial.

All programming and recording was done automatically in an adjacent room. Detection of the animal's position in the maze was determined by photocells, and once the day's session had begun, the E was free to observe the animal.

Detailed descriptions of the shock procedure have been presented elsewhere (Markowitz & Sorrells, 1969). Briefly, a correction procedure was used: a buzzer sounded 5 sec after the door was opened, and if the animal chose the correct compartment within 10 sec, shock was completely avoided; both shock and buzzer began (or continued) if the incorrect compartment was entered; shock and/or buzzer terminated when the correct compartment was entered; a 15-sec intertrial interval was used. Twenty-five Ss were used in the shock study summarized below, and 40 trials per S were run each day.

In the studies using food reinforcement, 24 Ss were maintained at 80%-85% of free-feeding body weight. The buzzer and shock were eliminated and each animal was run to a criterion of 10 consecutive correct choices each day. When a S entered the correct compartment, food was delivered.

RESULTS

The graphs in Fig. 2 represent the results for animals trained on successive light-correct and dark-correct problems (with spatial location of the correct stimulus randomized). The left-hand graphs are for food-reinforcement studies, while the others are for shock studies. Thus it is shown that, using positive rather than negative reinforcement, the difference between strains is more marked on successive problems. However, we must caution that these curves should be compared with the reservation that the shock studies were run with 40 trials each day, while in the later (food) experiments, Ss were run to criterion each day. The part that this procedural difference plays in determining the enhanced results for the second type of experiment is a question which requires additional research.

In each of these studies, it was found that S_3 animals were superior to S_1s ("maze-bright") beyond the .05 level of significance for the measures reported. The S_1s, in short, took more trials and made more errors in reaching criterion than the S_3s in both experiments. Latency of choice also was recorded, and again S_3s were "superior" (extreme variability among individual animals prevented statistical analysis of the group latency differences).

DISCUSSION

It is apparent that the S_3 animals are superior in terms of the task run in the automated maze. Rather than recollect the arguments which relate this finding to earlier seemingly contradictory results (see Markowitz & Sorrells, 1969), we would like to take this opportunity to mention several control studies which have been done, using the same maze, and which have not yet appeared in the literature.

First, some of our colleagues have suggested that we might find very different results if we used noncorrection rather than correction procedures. This was done (using

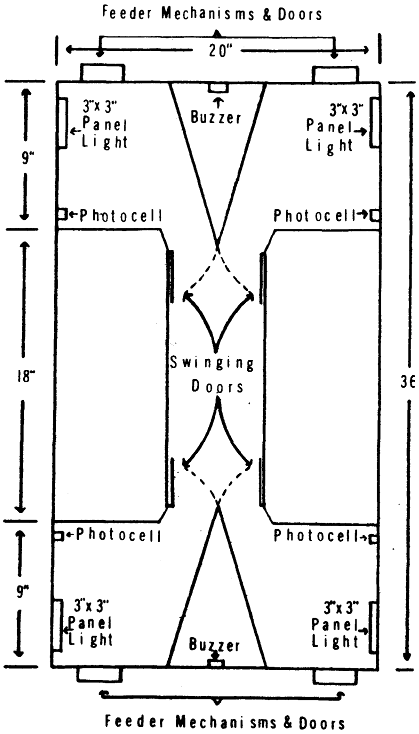

Fig. 1. Floor plan of automated maze.

positive reinforcement and locking the animal in the compartment he chose first, with or without food) and, although statistical analyses are not yet completed, the results are almost identical to those reported in this paper.

We have tried a variety of intertrial intervals (with smaller groups of animals) and have found little differential effect due to manipulating this variable over a range of 5 sec to 2 min. In all cases, the S_3s exhibited superior performance.

Two studies involving the most rudimentary spatial problem (left or right correct) have been run, reversing the problem four times for each S. No difference between the strains was observed, perhaps because all Ss solved the problems very quickly. Future research with more difficult (e.g., sequential) spatial problems may reveal some differences which will tie in with the early designations of "spatial and visual" animals, but it would be fruitless to conjecture further on this point until the results "are in."

In summary, we have run approximately 60,000 trials, and 100 animals of the S_1 and S_3 strains on automated "visual" maze tasks, and have consistently found the "dull" animals to be the better reversal discrimination learners. It is with considerably more confidence that we can now argue for abandoning the "dull" and "bright" labels as *generally* descriptive of the behavior of these strains. In addition, we would like to reinforce our earlier arguments that such labels are uncalled for on the basis of available evidence about any laboratory strains of rats.

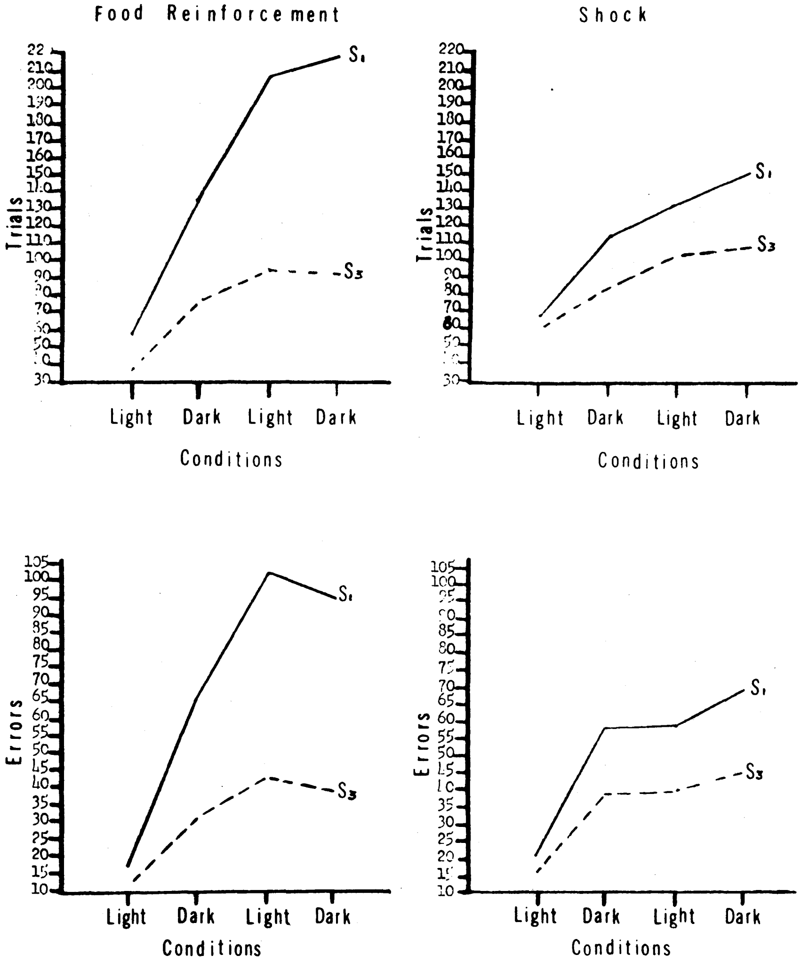

Fig. 2. Mean trials and errors to criterion for S_1 and S_3 animals.

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NOTES

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3. Reprints may be ordered from the first author.